

REPORT ON THE
POTENTIAL STONE QUARRY
MACKENZIE FARM, HARDWOOD HILL, PICTOU COUNTY

OFR 87-005

G. DICKIE

Mineral Development Division
Nova Scotia Department of Mines and Energy

DECEMBER 1986

Canada - Nova Scotia
Mineral Development Agreement





MacKenzie quarry site, facing north-east



MacKenzie quarry access route, facing west

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INTRODUCTION:

In response to a request from the Nova Scotia Department of Development, a program of geological evaluation and diamond drilling was carried out on a sandstone deposit located on the property of Mr. L. B. MacKenzie, Hardwood Hill, Pictou County. A total of 250 000 cubic metres of stone fill is required for the construction of the proposed common user dock for the town of Pictou. In addition some 12 000 cubic metres of armour stone is needed for the structure. Upon investigation it was discovered that adequate stone quarries are not readily available in Pictou County to supply this volume of rock. Two old sandstone quarries, the McKeen (Pictou) and Sawmill Brook were suggested as adequate sources (Fig. 1). However more detailed investigations revealed that neither quarry could supply the required volume of material. They could possibly supply a portion of the stone required for the contract however it should be noted that both quarries produced significant tonnages of dimension stone in the past and they may be better suited to supply limited quantities of dimension stone for the restoration market. The use of explosives in dimension stone quarries destroys the stone for building purposes. Extracting large tonnages of rip rap and 6 inch stone from either Sawmill Brook or the McKeen quarry would destroy their dimension stone potential.

This report describes the results of work carried out on an alternate quarry site and outlines an area which could produce large volumes of sandstone for fill and armour stone.

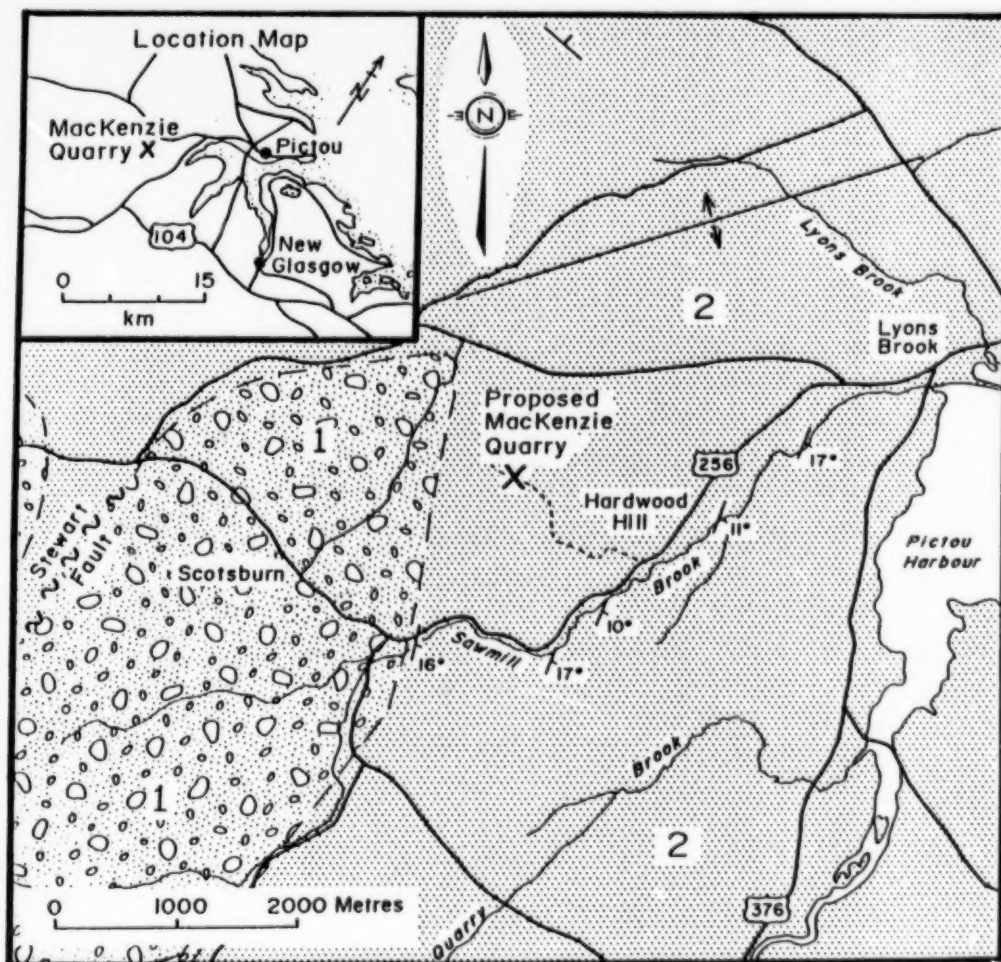
LOCAL GEOLOGY

The Hardwood Hill area is underlain by mid-Carboniferous conglomerate, sandstone and siltstone of the Riversdale Group (Fig. 2). The conglomerates of the Millsville Formation outcrop to the west of the study area and are characterized by pebble imbrication, coarse and poorly sorted with rare cross stratification. The geographic distribution and sedimentological factors of the formation indicate that the environment of deposition was a proximal alluvial fan (Ryan, 1985).

The Boss Point Formation is predominantly sandstone with interbeds of siltstone, shale and lag conglomerate. The study area is underlain by these rocks. The sandstone beds are trough cross stratified and tabular. Deposition probably took place in moderate to low sinuosity, meandering, sand dominated streams.

The rocks of the Hardwood Hill area strike 20° and dip 10 to 20° to the SE. A few kilometres to the north the beds strike 50° and dip 17 to 35° NW. Fletcher (1903) inferred an anticline crest trending from Heathbell to Lyons Brook plunging 20° to the NE.

Crystalline rocks of the Cobequid Highlands outcrop to the south of Hardwood Hill at Millsville and Dalhousie Mountain.



LEGEND

RIVERSDALE GROUP

2 BOSS POINT FM: PREDOMINANTLY FINE TO MEDIUM GRAINED TAN, BROWN AND GREY SANDSTONE WITH MINOR BROWN AND BLUE SHALE AND SILTSTONE.

1 MILLSVILLE FM: COARSE BOULDER TO PEBBLE CONGLOMERATE

SYMBOLS

~ FAULT (APPROX)

— — — — — GEOLOGICAL BOUNDARY (APPROX)

^ BEDDING, INCLINED
20°

Fig. 2: General Geology Hardwood Hill area, Pictou Co.

EXPLORATION PROGRAM RESULTS

Sandstone of undetermined thickness outcrops on the farm of Bruce MacKenzie (Fig. 3). The beds strike 20-30° and dip 10-15° SE. Overburden cover was very thin (.5 metre) over an area 300 metres square.

The object of this exploration program was to outline at least 500,000 tonnes of sandstone suitable for use as fill for the common user dock at Pictou. The topography of the study area consists of a ridge of bedrock trending north-south. The ridge is bounded to the west by a low wet area 21 metres below the crest of the ridge. Therefore it was assumed that the proposed quarry could be worked to a depth of 20 metres below the height of land without encountering significant water flow.

With a horizontal distance of about 100 metres from height of land to the swamp area and a wedge of stone rising from zero to 20 metres to the east, it was felt that 3 holes spaced 100 metres apart north and south would outline 750 000 cubic metres of stone if all holes intersected sandstone to a depth of 20 metres.

Diamond Drill Program

A Longyear 38 diamond drill was utilized for this project using BQ size rod for wireline recovery of drill core. The core measures 1 7/16" in diameter and was placed in wooden box consisting of five sections of core, five feet long. The core was carefully logged to determine rock type, colour, grain

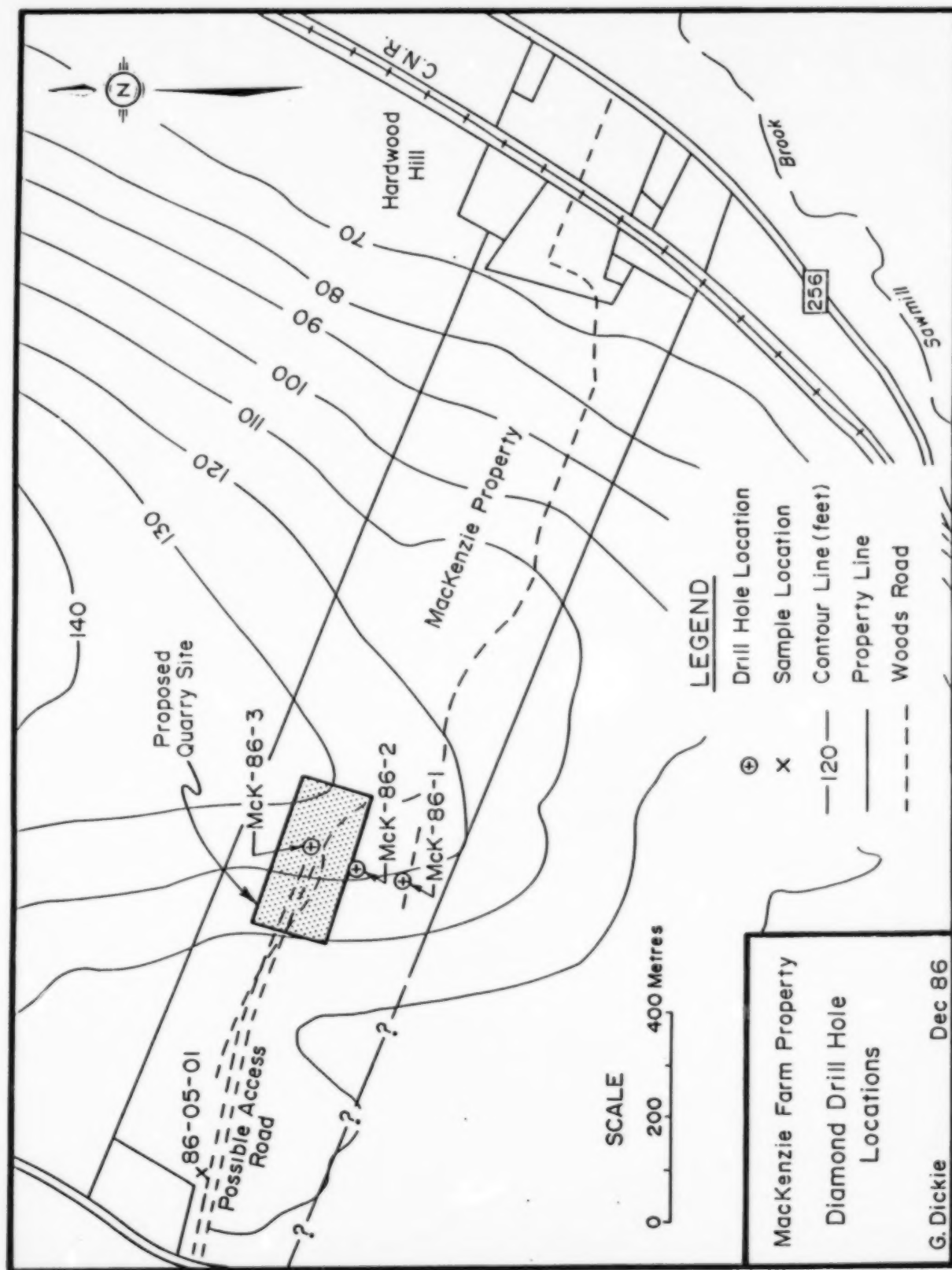


Fig. 3: Diamond drill hole locations, MacKenzie Farm, Hardwood Hill, Pictou County.

size, joint frequency, bedding angles, etc. Sampling was carried out using a common core splitter. Alternate pieces of core were removed from the boxes and split. One half was returned to the box, the other half was placed in a plastic sample bag. The upper 18.2 m section of holes McK-86-01, 02 and 03 were sampled in this manner. In addition, a 20 cm long unsplit piece of core was collected from a typical sandstone unit from each hole and placed in plastic sample bags for physical strength determinations.

Laboratory Analysis

Representative sample splits from each of the three drill holes were further prepared for chemical analysis by the Minerals Engineering Centre, TUNS. The following parameters were analyzed for: SiO_2 , Al_2O_3 , TiO_2 , FeO , Fe_2O_3 , CaO , MgO , Na_2O , K_2O and LOI.

In addition the three samples of unsplit core were prepared for modulus of rupture and crushing strength determinations. For the modulus of rupture tests the core was sawed into prisms measuring 1" x 1/2" by 4 1/2" with the two 1" wide flat surfaces lapped parallel. The sample was placed in a "Tonindustrie 50 kp" machine with a load applied until the sample broke (Fig. 4). This test is normally applied at right angles to bedding. However in this case, where drilling was done 90° to bedding, the modulus of rupture was performed parallel to bedding planes. The result is quoted in pounds per square inch (p.s.i.).

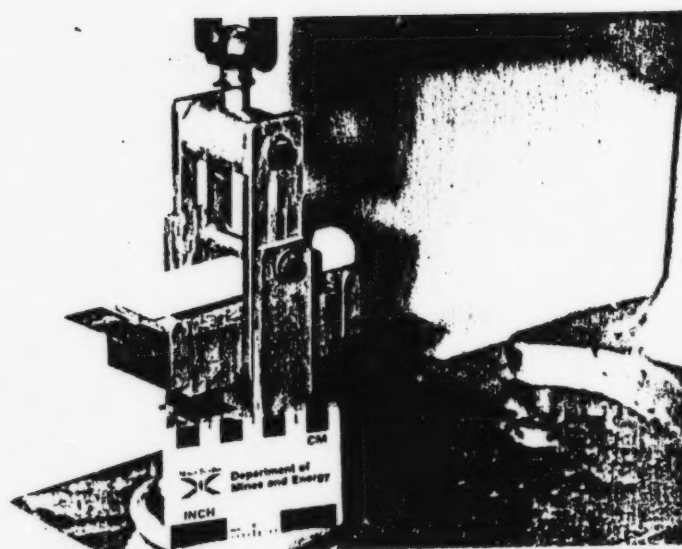
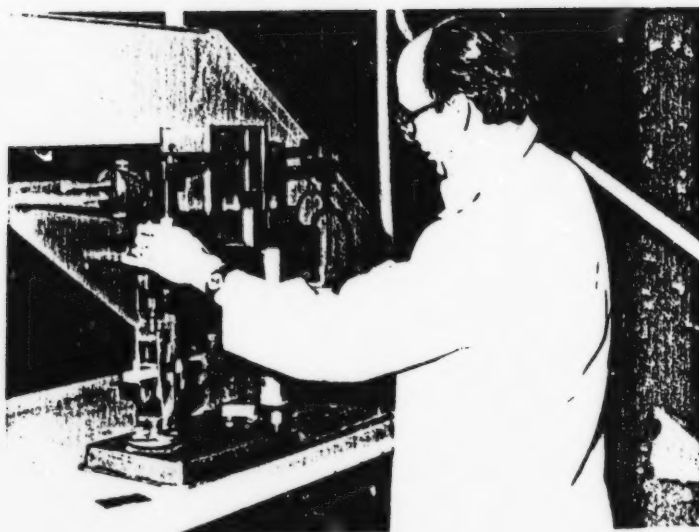


Fig. 4: Testing Modulus of Rupture

The crushing strength determination was done on a "Riehle" machine (Fig. 5). Round pieces of core were cut to 4" in length, lapped on the ends and weight applied parallel to the long axis of the core. This measurement was carried out perpendicular to bedding and on core dried at room temperature for a few days. Results are given in p.s.i.

Samples of broken core grading less than 1 1/2 inch were sent to Warnock Hersey Professional Services Ltd., 4 MacDonald Avenue, Dartmouth, Nova Scotia, for abrasion loss and soundness loss testing.

The abrasion test was performed on composite samples, one from each drill hole over the interval 0 to 18.3 metres. Five thousand grams of core was placed in the machine and revolved 500 times with 12 spheres. The loss was measured as the percentage of material passing #12 mesh.

The soundness loss was determined by the 5 cycle sodium sulphate method. Approximately 1000 grams of 1 1/2" to 1" and 500 grams of the 1" - 3/4" fractions were used for the test. The loss was reported as the percentage passing a 5/8" sieve.

DISCUSSION OF RESULTS

Diamond Drilling

Three holes were collared on the MacKenzie property (Figs. 3, 6). They were all drilled to depths of 30.5 metres. The collars of McK-86-01 and 02 are at the same elevation while McK-86-03 is 4.5 metres higher.

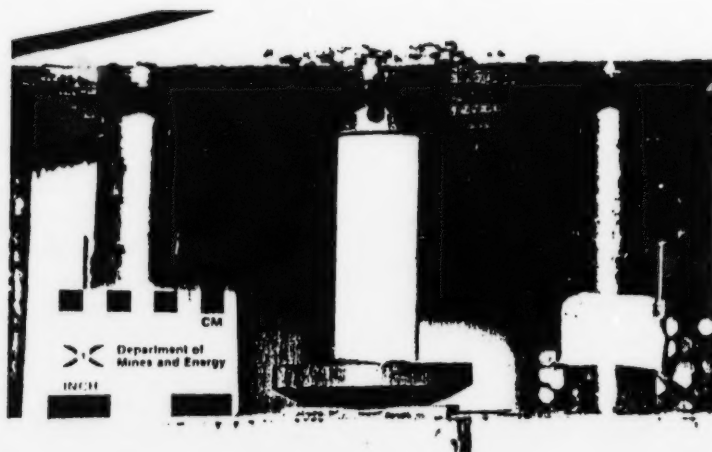


Fig. 5: Testing Compressive strength

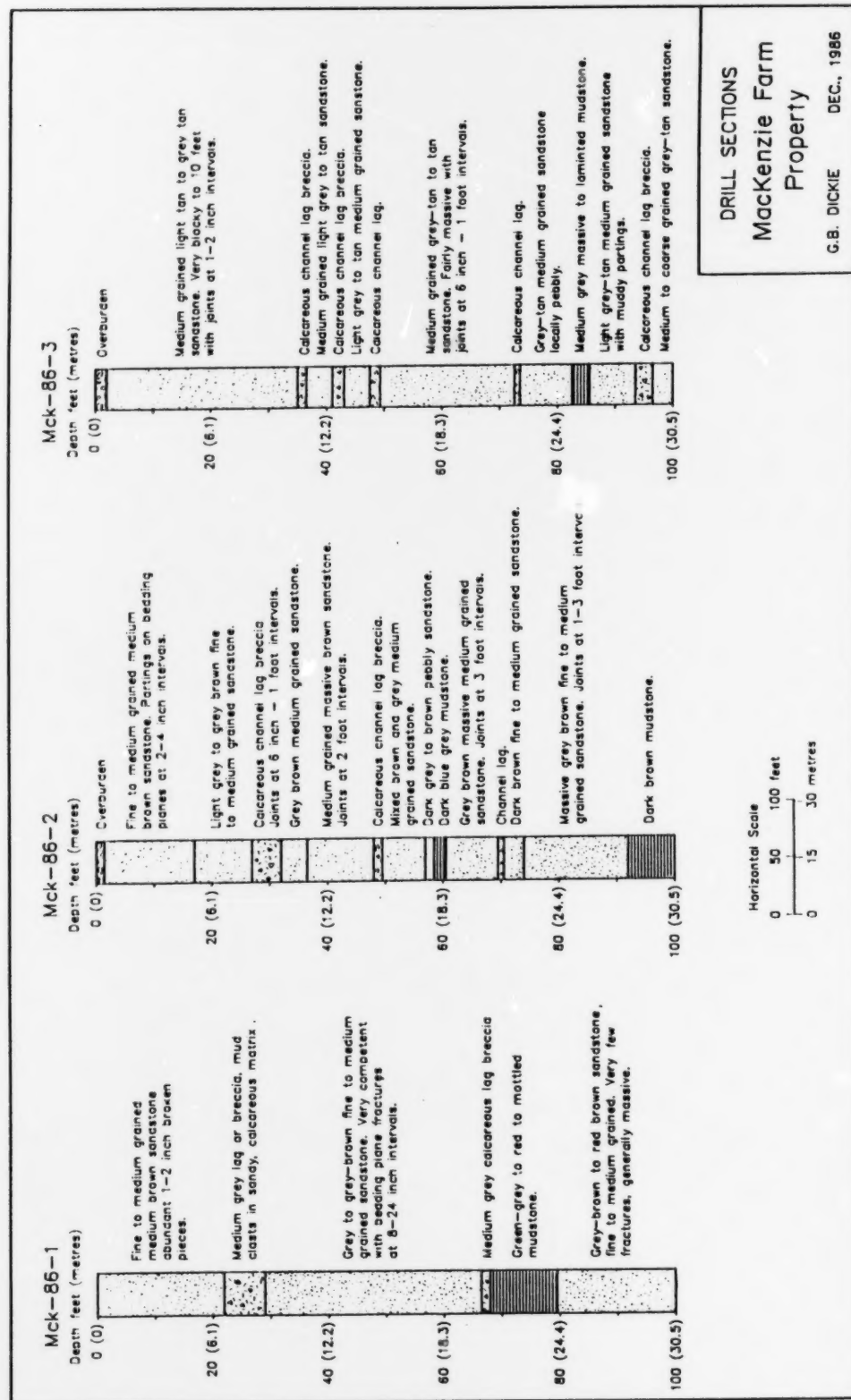


Fig. 6: Drill sections, MacKenzie Farm property.

McK-86-01 was collared in 6.7 m of fine to medium grained brown sandstone. The core was broken in 2 cm to 5 cm pieces. This was underlain by 2.4 m of calcareous channel lag breccia. This was underlain by grey to brown, fine to medium grained sandstone to a depth of 20.4 m. The sandstone is very competent with bedding plane fractures at 20 to 60 cm intervals. A unit of grey to red mottled mudstone was intersected under the sandstone to a depth of 24.4 m followed by grey to brown sandstone to 30.5 m.

McK-86-02 was collared 100 metres north of McK-86-01 in 0.6 m of overburden. The hole was predominantly medium brown fine to medium grained sandstone interbedded with calcareous channel lag from 8.5 to 9.8 m, from 11.9 to 12.2 m and from 21.3 m to 21.6 m. Minor mudstone was intersected over 18 to 18.6 m and the hole terminated in dark brown mudstone from 28 m to 30.5 m.

McK-86-03 was collared 100 metres north of McK-86-02 and cut 10.7 m of light tan medium grained sandstone. The upper 3 m was blocky with core broken at 2 cm to 5 cm intervals. This hole was predominantly sandstone with minor interbeds of calcareous channel lag breccias from 10.7 m to 11 m, 12.5 m to 13.1 m, 14.6 m to 14.9 m, 21.9 m to 22.3 m and 28.3 m to 29.3 m. A minor unit of grey massive laminated mudstone was cut from 25 m to 25.9 m. The sandstone in hole McK-86-03 appeared to be bleached and the calcareous channel lag was harder than in either of the other two holes. The physical and chemical analyses were similar between all three holes so the reason for the colour and apparent hardness difference of the rocks of McK-86-03 is not obvious. There may be a granite stock nearby which has thermally altered

the rock or differences in circulating groundwater, or other fluids, may have caused the bleaching.

The best section of sandstone occurs at McK-86-03 where good sandstone is present to a depth of 10.7 m. Hole McK-86-02 intersected the same sandstone to a depth of 7.6 m because the collar of McK-86-02 is 4.6 m lower than McK-86-03. An area 50 metres north and south of McK-86-03 by 200 metres east west, quarried to a depth of 12 metres would yield 240 000 cubic metres of sandstone. Additional reserves are present to the south towards McK-86-02 and McK-86-01. Drill indicated reserves could be 1.5 million cubic metres of sandstone from this site.

Physical Tests

Abrasion Test: Three composite samples submitted for testing gave abrasion losses which vary from 42.3% to 47.9% (Table 1). Considering that the material tested was sandstone, losses of this magnitude are not unusual. Although not suitable for asphalt or concrete mixes, this stone should be suitable for fill or rip rap.

Soundness Test

Results of the sodium sulphate soundness test (Table 1) vary from 8.9 to 9.3%. This loss is acceptable for both Hot Mix and Class A aggregate and indicates that the stone should be resistant to freeze thaw cycles in a marine environment.

Table 1

Abrasion & Soundness Tests

<u>Lab No.</u>	<u>904 A</u>	<u>904B</u>	<u>904C</u>
Client's Mark	86-01-23	86-01-25	86-01-27
Drill Hole #	McK-86-03	McK-86-01	McK-86-02
<u>Abrasion Test</u>			
Grading	1 1/2"-1"	1 1/2"-1"	1 1/2"-1"
Mass, grams	5000	5000	5000
Revolutions	500	500	500
Spheres	12	12	12
Percent Passing #12 Mesh	42.6	47.9	42.3
<u>Soundness Test</u>			
(5 cycles Sodium Sulfate)			
Grading: 1 1/2"-1", grams	1002	999	1003
1"-3/4", grams	490	500	497
Percent Passing 5/8" Sieve	9.3	9.1	8.9

Modulus of Rupture

A representative sample from each drill hole was tested for modulus of rupture (Table 2). The results vary from 843 psi to 962 psi tested parallel to bedding. Had it been possible to test perpendicular to bedding planes, the results would have been 20-30% higher.

Crushing Strength

A representative sample from each drill hole was tested for crushing strength (Table 2). The test was performed on round drill core which was air dried for a few days only. Results vary from 7486 psi to 8520 psi. Had the test been performed on dry cubes the results would have been higher.

Chemical Analyses

Chemical analysis (Table 3) reveal that composite samples from each of three drill holes are remarkably similar. All major element values are statistically similar and the FeO ranges from 1.03% to 1.09%. No deleterious substances were identified through the chemical analyses.

CONCLUSIONS AND RECOMMENDATIONS

A diamond drill program, on the MacKenzie property consisting of three holes totaling 91.4 metres has outlined up to 1.5 million cubic metres of sandstone.

Abrasion and soundness losses average 44.3% and 9.1% respectively. Chemical analyses of the rock show a uniformity of composition between the three drill holes thus indicating a uniform product. Examination of drill core

Table 2

Modulus of Rupture

<u>Drill Hole #</u>	<u>Sample #</u>	<u>lbs/sq. in</u>
McK-86-03	86-01-07	843
McK-86-01	86-01-14	962
McK-86-02	86-01-21	952

Crushing Strength

<u>Drill Hole #</u>	<u>Sample #</u>	<u>lbs/sq. in</u>
McK-86-03	86-01-07	7486
McK-86-01	86-01-14	8410
McK-86-02	86-01-21	8520

Table 3

Sample #	86-01-22	86-01-24	86-01-26
Drill Hole #	McK-86-03	McK-86-01	McK-86-02
SiO ₂ %	83.39	83.80	83.48
Al ₂ O ₃ %	6.41	6.68	7.69
TiO ₂ %	0.35	0.37	0.42
FeO%	0.74	1.00	1.00
Fe ₂ O ₃ %	1.08	1.05	1.03
CaO%	0.73	0.67	0.68
MgO%	0.57	0.63	0.69
Na ₂ O%	1.12	1.18	1.19
K ₂ O%	2.56	2.79	2.89
LOI%	1.51	1.42	1.60
Total Oxides	98.46	99.59	100.67
Total Fe as Fe ₂ O ₃	1.90	2.16	2.14

indicates that the upper 6 m of the deposit may be broken on 0.6 m or less bedding planes. The sandstone intersected below 10.7 m in all three holes may be suitable for dimension stone as bed heights of up to 1.5 m may be present. This factor should be taken into account when planning for and executing the removal of fill and rip rap material. Care should be taken when blasting for fill material that stone suitable for dimension blocks is not damaged.

The stone outlined by this work may be suitable for fill, rip rap and dimension stone. In order to prepare the site as an operational quarry it is necessary to (a) construct 500 metres of gravel road to the site, (b) clear and strip the trees and overburden from the quarry site and (c) quarry, stockpile and test several hundred cubic metres of stone. If the stone meets quality parameters for specific projects, quarrying could begin as soon as the aforementioned work is completed.

Reference

Fletcher

1903 Geological Survey of Canada Map number 46, Pictou Sheet.

Ryan, R. J.

1985 Upper Carboniferous strata of the Tatamagouche Syncline,
Cumberland Basin, Nova Scotia; in Current Research, Part B,
Geological Survey of Canada, Paper 85-1B, p. 481-490.

Appendix I
Diamond Drill Logs

Sheet 1 of 2

PROPERTY: MacKenzie Farm, Lyons Brook

Drilling Performed By

N.S. Department of Mines & Energy

G. Prime
Signature

Geologist

NOVA SCOTIA DEPARTMENT OF MINES AND ENERGY
DIAMOND DRILL RECORD

Sheet 1 of 2

PROPERTY: MacKenzie Farm - Lyons Brook HOLE NO. McK-86-02

3° M.T.M. Northing 5058446.16		Easting 200820.36		Elevation 118.94 m		Section From: 0		To: 21.3 m				
Datum M.S.L.		Bearing		Dip -90°	Started (date) 17/11/86		Completed (date) 20/11/86		Ultimate Depth 30.5 m	Proposed Depth 30.5 m		
Depth in Metres		F O R M A T I O N								ASSAY VALUES		
0-0.6	Overburden									86-01-08	0-10'	
0.6-5.5	Fine-med grained med. brown sandstone. Minor organic partings locally. Core angle to bedding 80°. Rock is blocky @ 10-15 cm spacing.									86-01-09	19-20'	
										86-01-10	20-30'	
										86-01-11	30-40'	
5.5-8.5	As above but tends to light grey to grey brown. Minor mudstone @ 6.9-7.0 m. Rock jointed @ 10-20 cm intervals.									86-01-12	40-50'	
										86-01-13	50-60'	
8.5-9.9	Calc. channel bx. Rock is hard & joints @ 15-30 cm intervals.									86-01-14	42.5-43.5'	
9.9-11.3	Grey-brown med. gr. sandstone laminated & joints @ 30-60 cm intervals											
11.3-15.0	Med gr. massive brown sandstone joints @ 60 cm intervals											
15.0-15.3	Channel bx. calcareous											
15.3-17.5	Mixed brown & grey med. gr. sandstone. Minor organic partings & mudstone bands.											
17.5-17.6	Coal with pyrite.											
17.6-18.1	Grey brown pebbly sandstone.											
18.1-18.7	Dk blue grey mudstone. Massive.											
18.7-21.3	Grey brown massive med gr sandstone. Joints @ 1 m intervals.											

Drilling Performed By

N.S. Department of Mines & Energy

Signature G. Dickie

Geologist

Agency

NOVA SCOTIA DEPARTMENT OF MINES AND ENERGY
DIAMOND DRILL RECORD

Sheet 1 of 2

PROPERTY: MacKenzie Property

HOLE NO. McK-86-03

3° M.T.M. Northing 5058523.19			Easting 200853.38		Elevation 123.32 m		Section From: 0		To: 28.8 m		
Datum M.S.L.	Bearing	Dip -90°	FORMATION			Started (date) 10/11/86	Completed (date) 14/11/86	Sample Number	Width of Sample	Ultimate Depth 30.5 m	Proposed Depth 30.5 m
Depth in Metres	ASSAY VALUES										
0-0.6	Overburden										
0.6-10.6	Med. grained light tan to grey-tan sandstone. Very blocky to 3.0 m with joints @ 2-5 cm intervals. After joints @ 0.6-1 m intervals										
10.6-10.9	Calc. channel bx. with blue grey mudstone										
10.9-12.3	Med. gr. lt. grey-tan sandstone. Minor mudstone clasts & organic partings										
12.3-13.0	Calc channel bx. Broken @ 15-30 cm intervals										
13.0-14.3	Lt. grey-tan med. gr. sandstone with pebbly section @ 13.4m										
14.3-14.8	Channel bx. sandstone matrix, sandstone and mudstone clasts										
14.8-21.9	Med. gr. grey-tan to brownish-tan sandstone. Rock broken @ 15-30 cm intervals										
21.9-22.3	Channel bx.										
22.3-25.0	Grey-tan med. gr. sandstone with pebbly unit @ 23.9-24.1										
	Muddy partings @ 24.7 m.										
25.0-26.1	Med. grey massive to laminated mudstone										
26.1-28.8	Lt. grey-tan med. gr. sandstone with muddy partings										

Drilling Performed By

N.S. Department of Mines & Energy

Agency

Signature

G. Dickie

Geologist

NOVA SCOTIA DEPARTMENT OF MINES AND ENERGY
DIAMOND DRILL RECORD

Sheet 2 of 2

PROPERTY: MacKenzie Property

HOLE NO. MCK-86-03

Latitude		Departure		Elevation		Section From: 28.8 To: 30.5 m	
Datum	Bearing	Dip	Started (date)		Completed (date)		Ultimate Depth
Depth in Metres	F O R M A T I O N						
	@ 26.8m Rock broken @ 30 cm intervals.						
28.8-29.6	Calc. channels Bx. with mudstone fragments						
29.6-30.5	Med. to coarse grained gray-tan sandstone channel bx.						
	@ 29.9 m						
	End of Hole @ 30.5 m						

Appendix II

- (A) Test Results on Gravel Deposit
- (B) Test Results on Sandstone Stockpile

(A) TEST RESULTS ON GRAVEL DEPOSIT

A small deposit of stratified sand and gravel occurs on the MacKenzie property approximately 600 metres west of the sandstone quarry. Excavator pits dug in the deposit exposed 2 feet of a silty-clay till overlying 6 feet of indurated, laminated gravel and coarse sand, overlying conglomerate of the Millsville Formation. The deposit appears to extend over an area of about 200 by 100 metres for a volume of 40,000 cubic metres. The surface expression of the deposit is hummocky and could be a remnant kame field. The indurated nature of the gravel is characteristic of deposits resulting from ice advances prior the most recent one which occurred 12,000 to 20,000 years ago. The gravel is overlain by a till layer which also implies that the gravel is older than the till.

A pebble count of clasts in the gravel revealed that 95% were granite or volcanic in composition with the remainder metasediment or sandstone. The source area for the gravel was probably the crystalline rocks of the Mount Thom, Fitzpatrick Mountain area to the south.

The gravel is underlain by coarse to fine conglomerate. Clasts composed of granite, rhyolite and metasediments in a siliceous/carbonate matrix comprise this rock. This material when crushed has a similar composition to the overlying gravel.

Two samples were collected from the gravel deposit. Sample 86-05-01 was collected from a 4 foot exposure of gravel and till in an old bulldozer excavation (Fig. 7). The sample contained at least 70% till.

Gradation, soundness loss, petrographic analysis and particle description tests (Exhibits 1 a, b, c, d) were performed by Warnock Hersey Professional Services Ltd., Dartmouth, Nova Scotia. The sample contained a large proportion of fines (66.3% passing #4 sieve) and very little stone (100% passing 1 inch). The material failed to meet DOT specifications for Class A granular aggregate although the grading is suitable for hot mixed asphalt. The soundness loss and petrographic analysis meet DOT specifications for Class A and hot mixed asphalt.

Sample 86-05-02 was collected from a newly excavated pit and was comprised of about 50% indurated gravel and 50% conglomerate. The sample was crushed to 1 1/2 inch and screened by the Minerals Engineering Centre-TUNS, Halifax. The results (Exhibit 2) indicate that the material is suitable for Class A and hot mixed asphalt aggregate. Pebble counts suggest that the petrographic number is equivalent to or better than the 140 value returned for sample 86-05-01.

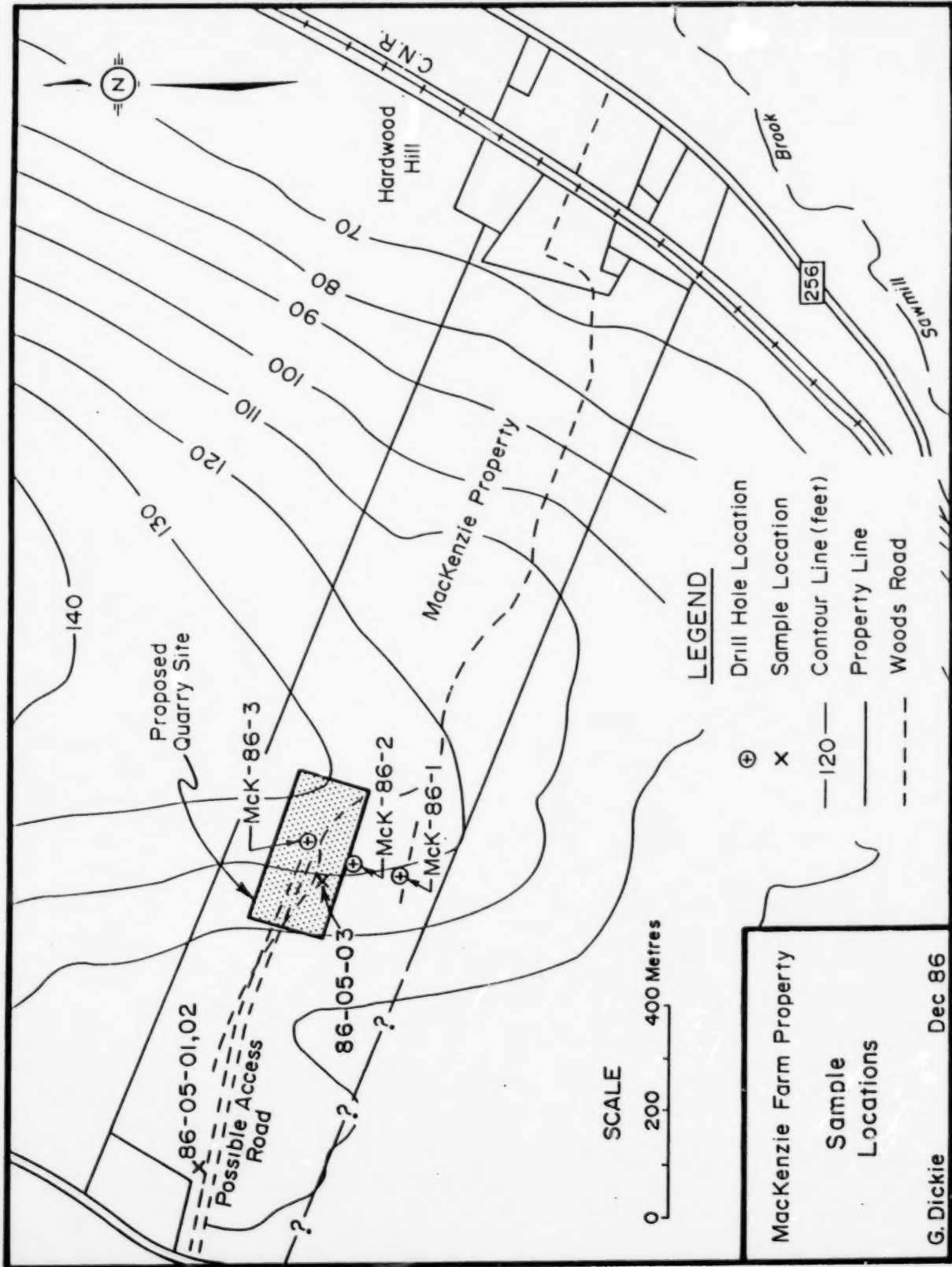


Figure 7. Sample locations, MacKenzie Farm property.

AGGREGATE QUALITY REPORT
 FOR MINERALS ENGINEERING CENTER TECHNICAL UNIVERSITY OF NOVA SCOTIA, HALIFAX

Contract No. Purchase Order No. 0047 Laboratory No. 86-05-01 Date January 5, 1987

Description of Sample: 25 Kg Bank Run Gravel

Type of Mix: Granular A

Source: MacKenzie Pit

Sampler: Gordon Dickie Date Sampled: Received in lab Dec. 12

Contractor: ---

DATA: 1. Grading Analysis *

% Held 5mm 33.7 % Passing 5mm 66.3 % Passing 80µm 4.8

2. Los Angeles Abrasion Test

Grading B Percent Loss after 500 revolutions Insufficient Sample

3. Soundness (5 cycles of Sodium Sulfate) *

Total Weighted Loss of Coarse Aggregate, Percent 7.8

4. Petrographic Analysis (Modified D. H. O. Method) *

Proportional Petrographic Number 140.0

5. Bulk Relative Density — 23/23°C

N/A

6. Water Absorption — % Dry

N/A

7. Particle Description

Shape Sub Angular Percent Crushed Particles Not Counted

SUITABILITY: ☒ Meets Department Specifications: for Petrographic Number 150 maximum and soundness.

☐ Fails to meet Specifications because:

REMARKS: *See tabulations attached for detailed analysis.

Sand content is high but sand grading itself is acceptable for Hot Mixed asphalt.
 N.B. Stone fraction is of relatively good quality but content is low.

K.R. Mosler, C.E.T., Supervisor

LABORATORY SUPERVISOR



EXHIBIT #1b
Warnock Hersey Professional Services Ltd.

4 MacDonald Avenue Dartmouth Nova Scotia B3B 1C5 (902) 463-6130

50544-C7-026400

32

AGGREGATE GRADATION TEST DATA

CLIENT: Minerals Engineering Center - Purchase Order No. 0047M
Technical University of Nova Scotia

DATE: January 5, 1987

SAMPLE NOS. 86-05-01

MATERIAL SOURCE/DESCRIPTION: 25 Kg of Bank Run Gravel
Marked: MacKenzie Pit

SAMPLED/SUBMITTED BY: Gordon Dickie - Dept. of Mines, N.S. on Dec. 12
Marked: Proposed for "Road Gravel"

SAMPLE NO.		905								DOT NS
SIEVES		%	CUM. %	%	CUM. %	%	CUM. %	%	CUM. %	SPECIFICATION
In.	mm/um	RETAINED	PASSING	RETAINED	PASSING	RETAINED	PASSING	RETAINED	PASSING	% PASSING Limits
3	80									Granular, Class A
2	56									
1 1/2	40									
1	28		100.0							
3/4	20	1.2	98.8							100
1/2	14	6.7	92.1							50-85
3/8	10	9.8	82.3							---
4	5	16.0	66.3							20-50
8	2.5	12.6	53.7							
16	1.25	16.6	37.1							
30	630	15.0	22.1							
50	315	9.1	13.0							
100	160	4.8	8.2							0-10
200	80	3.4	4.8							0-5
-200	-80	4.8	--							
Total		100.0	--							

REMARKS: Sample is too fine (see 5mm Sieve Size) to meet Department of Transportation N.S. limits.

TECHNICIANS: C. D. Thornhill

SUPERVISOR: K.R. Mosher, C.E.T., 

Warnock Hersey Professional Services Ltd.

50544-C7-026400

PETROGRAPHIC ANALYSIS (DOT NS Method)

Purchase Order No. 0047M

CONTRACT NO. _____ LAB NO. 86-05-01 DATE January 5, 1987DESCRIPTION OF SAMPLE 3/4" Lab Cr. MIX TYPE 3/4SOURCE MacKenzie PitCONTRACTOR --- DATE SAMPLED ---

ROCK TYPES	QUALITY (PERCENT)			
	EXCELLENT (1)	GOOD (3)	FAIR (6)	POCR (10)
SANDSTONE	7.1		2.3	0.9
GRANITE	16.5	0.4		
VOLCANIC	63.7	7.6	0.6	
SILTSTONE		0.4		
TOTALS	87.3	8.9	2.9	0.9

PETROGRAPHIC NUMBER 140.0

Warnock Hersey Professional Services Ltd.

50544-C7-026400

SOUNDNESS TEST FIVE CYCLE SODIUM SULPHATE
ASTM DESIGNATION C-88-83

Client: Minerals Engineering Center
 Technical University of Nova Scotia
 Purchase Order No. 0047M

DATE: Jan 5/87

NAME OF PIT: MacKenzie

Sample No. 86-05-01		Description of Material Stone Fraction (33.7%)	
Sieve Size Held On	% Loss Each Frac.	Prepared Grading Percent	Percent Loss Weighted on Prepared Grading
Coarse Aggregate (mm)			
1" (25)		---	
3/4" (20)	(6.7)	3.6	)
1/2" (14)	)	19.9	)
3/8" (10)	) 6.7	29.0	) 3.5
No. 4 (5)	9.0	47.5	4.3
TOTALS	15.7	100.0	7.8

Mode of Failure: Breakage of volcanics and some brittle granite.

Exhibit 2

Date: January 16, 1987
Sample No.: 86-05-02

Aggregate Gradation Test Data

Lab Analysis: Minerals Engineering Centre - TUNS

Material Source/Description: 30 kg of mixed bank gravel and conglomerate

Sampled/Submitted By: Gordon Dickie - Nova Scotia Department of Mines and Energy

Preparation: Sample crushed to minus 2 inch

				DOT NS Specification % Passing Limits Granular Class A
In.	mm/mm	% Retained	Cum. % Passing	
2	56	-	100	
1 1/2	40	1.84	98.16	
1	28	9.16	89.00	
3/4	20	10.38	78.62	100
1/2	14	13.05	65.57	50-85
3/8	10	9.12	56.45	-
4	5	14.43	42.02	20-50
8	2.5	11.30	30.72	
16	1.25	12.57	18.15	
30	630	7.04	11.11	
50	315	4.70	6.41	
100	160	2.90	3.51	0-10
200	80	1.74	1.77	0-5
-200	-80	1.64	-	
		99.87	-	

(B) TEST RESULTS ON SANDSTONE STOCKPILE.

Approximately 30 kg of stockpiled sandstone was collected for grading analysis. The sample selected (86-05-03) is representative of the stockpile for fractions finer than 3 inch. The relative percentage of +3 inch material in the stockpile is probably higher than the value returned by the laboratory (Exhibit 3). Summarizing the gradation results, 78.2% of the sample was coarser than 1/2 inch, 30.52% was coarser than 4 inch and only 1.49% was finer than 200 mesh. This material will make excellent fill where a low fine content is required on projects where silt contamination of water is a concern.

Exhibit 3

Date: January 16, 1987Sample No.: 86-05-03

Aggregate Gradation Test Data

Lab Analysis: Minerals Engineering Centre - TUNSMaterial Source/Description: 30 kg of stockpiled sandstone, MacKenzie QuarrySampled/Submitted By: Gordon Dickie - Nova Scotia Department of Mines and Energy

In.	mm/mm	% Retained	Cum. % Passing 100
4		30.52	69.48
3	80	13.44	56.04
2	56	8.50	47.54
1 1/2	40	5.87	41.67
1	28	9.46	32.21
3/4	20	5.28	29.93
1/2	14	4.95	21.98
3/8	10	3.91	18.07
4	5	4.50	13.57
8	2.5	2.09	11.48
16	1.25	1.85	9.63
30	630	1.33	8.30
50	315	2.25	6.05
100	160	3.51	2.54
200	80	1.05	1.49
-200	-80	<u>1.49</u>	—
		100.00	